

Insects for Weed Control: Status in North Dakota

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Two foreign species of weevils have been introduced into North Dakota for the biological control of musk thistle, *Carduus nutans* L. — *Rhinocyllus conicus* (Froelich), a seed feeding weevil, and *Ceutorrhynchidius horridus* (Panzer), an internal root and lower stem inhabiting species. *R. conicus* has survived for several generations and is showing some promise for thistle suppression in Walsh County, but releases of *C. horridus* have been unsuccessful. The pigweed flea beetle, *Disonycha glabrata* (Fab.), which is native in southern United States, has been introduced into experimental sugarbeet plots in the Red River Valley for testing its effects at controlling rough pigweed or redroot, *Amaranthus retroflexus* L. Although both larvae and adults of these beetles feed heavily on pigweed, damage to the weed occurs too late in the season for them to be effective in suppressing weed growth or seed set. An initial survey for native insects of bindweed has been conducted. Feeding by localized populations of various insects, particularly tortoise beetles, has been observed. Several foreign species of flea beetles and a stem boring beetle are anticipated for release against leafy spurge.

Entomologists at North Dakota State University are studying insects that feed on weeds to determine if the insects can reduce populations of selected weeds to levels at which the weeds no longer are economically important — and hence no longer “weeds”. This type of work is an example of biological control.

Biological control has been defined as an attack upon a noxious organism by an interference with its ecological adjustment. The nature of the interference usually involves a natural enemy — diseases, predators, parasites.

The most familiar biological control programs have involved the use of parasitic or predaceous insects to suppress other insect pests. As early as the ninth century the Chinese used predaceous ants against citrus pests. One of the first done and probably the most spectacularly successful biological control project in modern times was the introduction of the vedalia beetle from Australia into California in 1888 to control the cottony cushion scale. Within two years of its introduction, this beetle completely controlled the scale and literally saved the citrus industry.

Insects vs. Weeds. The use of insects to control weeds is of more modern origin, but several projects have been

successful. In 1940, the cactus-feeding moth, *Cactoblastis cactorum* (Berg), was transported from its native Argentina to Australia where it greatly reduced the numbers of prickly pear cactus, *Opuntia* spp. In the 1960's the leaf-feeding chrysomelid beetle, *Chrysolina quadrigemina* (Suffrian), imported from Europe to the United States via Australia, successfully controlled the poisonous range weed, *Hypericum perforatum* L. At the present time there are over 70 species of weeds which are under study or consideration for control by biological means (Andres et al. 1976.)

Because of their size, their high rate of reproduction, and in many cases their high host specificity, insects have received special consideration for biological control projects. More recently other kinds of “biological interference” with weeds have come to include studies of plant diseases (often transmitted by insects), nematodes, other organisms and competing plants.

No two weeds act the same and thus are “weeds” for different reasons. The threshold of economic damage varies with the weed species and conditions where it grows. Therefore, biological control studies are unique for each weed species. Before a particular plant species is considered as a suitable subject for a biological control project, various factors concerning the plant are taken into account — for example, whether the plant is

native or introduced, whether it has close plant relatives of economic importance, or if under different circumstances the weed itself may be a desirable plant. For example, many species of insects having potential for control of thistles have been rejected for use because they also attack cultivated artichoke. An example of a plant involved in a conflict of interest is Johnsongrass, *Sorghum halepense* (L.) Pers., which is a weed in many states but has some forage value in at least one southern state. Introduction of biological control agents against Johnsongrass might therefore be suspect.

Most examples of successful biological control of weeds by insects have usually involved the introduction of an insect to feed on an introduced weed. Secondly, most of these successes have involved weed pests in rangeland, pastures, or waterways — places relatively undisturbed by cultivation.

It is logical to go places where the weed is native to seek out its natural enemies in the hopes of finding ones that are not present where the weed has been introduced. This involves a thorough study of the literature and herbarium collections to learn exactly where the plant is found. Because it is expensive to fund concurrent foreign excursions for the purpose of collecting weed-eating insects, many ecological aspects are considered. Tests are made to determine host specificity. These tests eliminate many potentially effective candidates. For example, only five of the 51 cactus insects imported into Australia against prickly pear were of value for its control (Andres et al., 1976). Only the best candidate insects are considered. Obtaining candidates includes consideration of matching climatic conditions of the native areas to those of the new territories, obtaining political cooperation of the countries to be searched, and logistics of getting the insects out alive and to a laboratory. We recommend the article by Paul H. Dunn (1980) in which he describes some of his day-to-day experiences in Turkey, Pakistan, Afghanistan, and the Russian Ukraine while searching for insects on leafy spurge for possible introduction into the United States. Such romantic-sounding travel is not a bed of roses, but more likely a bath of toxic latex from the spurge!

Musk thistle. The first attempt to control weeds in North Dakota using insects involved the introduction of a seed feeding weevil, *Rhinocyllus conicus* (Froelich) (Fig. 1) against musk thistle or nodding thistle, *Carduus nutans* L. These weevils lay their eggs on the bracts surrounding thistle buds. The larvae which hatch bore into the flower heads and destroy the developing thistle seeds.

In 1975, releases of adult *R. conicus* were made at three sites in northeast North Dakota. On June 11, 300 weevils were released northeast of Langdon (Pembina Co.) — 10 weevils per uncaged plant and 25 weevils per plant under two conical screen cages which measured 46 cm high with a diameter of 46 cm. On June 12, 35 weevils were placed in a 1 m³ cage at the Langdon Experiment Station (Cavalier County). The same day 10

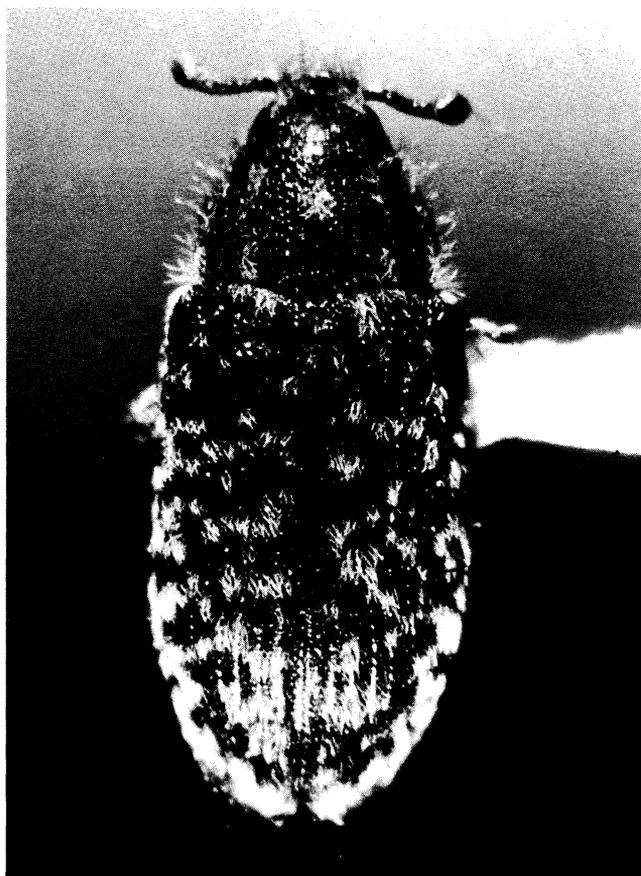


Figure 1

weevils were placed on each of 22 plants near Edmore (Ramsey Co.). All these weevils were obtained from a colony established in Montana that originally had been introduced from the Old World.

The three release sites were checked in June, 1976. Both adults and larvae were found at the Edmore site and adults were found at the Langdon Experiment Station. No weevils or evidence of activity were observed at the site northeast of Langdon.

A second release of 200 adult weevils from an established colony at Yankton, South Dakota, was made at the Langdon Experiment Station in August, 1978. By August, 1979, no more weevils or evidence of them could be seen at any of the release sites except for a single adult weevil observed at the Langdon Experiment Station. This specimen was an offspring of beetles collected in South Dakota in 1978.

In May of 1979, 8,000 specimens of *R. conicus* were collected at a well-established site near Bozeman, Montana. Approximately half were released near Park River (Walsh Co.); the others were released at the site northeast of Langdon. A recheck of these sites in August, 1979, revealed extensive production of adults, the overwintering stage. New adult weevils averaged 11.1 per flower head at the Walsh County site and 4.5 per head at the Pembina County site. Likewise a higher percentage of flower heads were infested in Walsh County.

In June, 1980, 100% of the flower heads at the Walsh County site had egg masses on them and the weevil populations were still doing well in August when more than 90% of the heads contained weevils. The weevils dispersed naturally and in 1980 had infested flowers of the original release point. By 1981, weevils could be found in 90% of the thistles over the half section in which they originally were released. A reduction of thistles at the point of release was evident after one year. We are not certain if this can be attributed solely to weevil activity, but hope that the success observed will continue.

Overwintering and/or establishment of *R. conicus* northeast of Langdon was less successful. Only a few adults were observed ovipositing in June 1980, and egg masses were seen on less than 50% of the thistle heads. Drought was a significant factor; only 1 inch of moisture was recorded for the preceding eight months and consequently the weed population was reduced and stunted. In addition to the drought, the weeds had been mowed, which effectively destroyed the homes of the developing weevils. But mowing also enhanced floral development by stimulating growth of lateral buds. Unfortunately no weevils were found at this site in 1981.

Recent experiments in Virginia lead to the conclusion that with proper timing of herbicide application, *R. conicus* and 2,4-D are compatible when used in an integrated control program for *Carduus* thistles (Trumble and Kok, 1980).

A second weevil, *Ceutorhynchidius horridus* (Panzer) (Fig.2) was imported from Italy to the United States because of its potential for musk thistle control. Unlike *R. conicus*, *C. horridus* is a root and stem inhabiting species. The larvae of this insect develop within basal plant tissues. During the winter of 1978-79, several shipments of eggs of *C. horridus* were received from the U. S. Department of Agriculture Laboratory for Biological Control of Weeds in Albany, California. Immediately upon receipt, the eggs were placed in a small slit in the basal stem of potted greenhouse thistles. In the spring of 1979, the greenhouse thistles, hopefully containing maturing larvae or pupae, were transplanted in the thistle stand at the Langdon Experiment Station. The reproductive potential of *C. horridus* is not as great as that of *R. conicus*, and adults of this weevil have not been found in the field since the release. This fact, and the failure to find developing weevils upon dissection of several plants, led us to conclude that the experiment with *C. horridus* failed.

Rough Pigweed. In comparison to using introduced insects to fight introduced weeds, as is the case with the thistles and weevils described above, very few attempts have been made at using native plant-feeding insects to control native weeds.

Rough pigweed, or redroot (*Amaranthus retroflexus* L.), is a native annual weed severe in row crops including sugarbeets in the Red River Valley of the North. Pigweeds are native in the Western hemisphere, and are

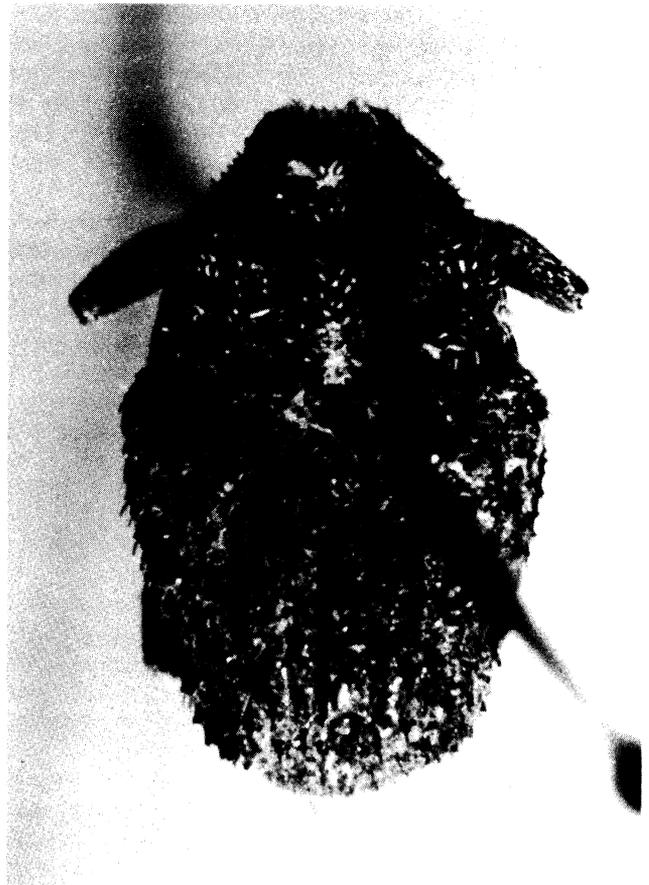


Figure 2

found as far south as Argentina. Other species of pigweeds are important pests near Buenos Aires, as well as in Uruguay and Paraguay. Two entomologists, Vogt and Cordo (1976), traveled to South America to search for weed feeding insects, including species that eat pigweed.

They concluded that both tropical and temperate insects might be used in "manipulative releases" and suggested mass rearings and releases of insects for biological control of weeds in row crops. Tropical insects could be introduced into the United States to feed in the summers where winters would serve to "turn off" a population in a manner similar to the "turn it on, turn it off" features of chemical control. Insects that Vogt and Cordo studied in South America included *Disonycha glabrata* (Fab.), the pigweed flea beetle (Fig. 3), which is an important suppressant of pigweeds in Brazil and Argentina. This beetle is also native in North America from Massachusetts to Florida, west to Indiana and Missouri, and southwest to Colorado and Arizona (Blake, 1933, and Mignot, 1970). It also occurs throughout Mexico, Central America, and the islands of the West Indies (Blake, 1955).

P. C. Quimby, Jr., U. S. Department of Agriculture Southern Weeds Laboratory in Stoneville, Mississippi, suggested that we test a manipulative release of *D. glabrata* on pigweeds in the Red River Valley..

The life history of *D. glabrata* has been recorded in Arkansas by Hemenway and Whitcomb (1968). In Arkansas, as well as throughout South America, its most important food plant is rough pigweed, or redroot, *Amaranthus retroflexus* L. Because the genus *Disonycha* also includes two other species, *D. xanthomelas* (Dalman) and *D. collata* (Fab.), which feed on sugarbeets (Wilcox, 1979), Dr. Quimby tested feeding behavior of the pigweed flea beetle in Mississippi on sugarbeets before sending the beetles for release in the Red River Valley. The feeding test proved negative.

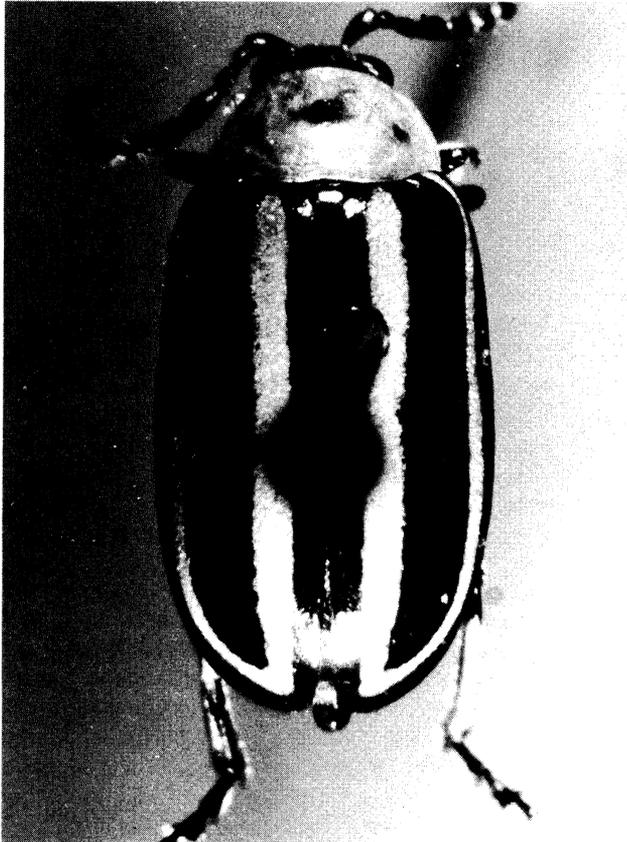


Figure 3

Field tests with the pigweed flea beetle were conducted for two summers by NDSU entomologists. In June, 1979, approximately 125 adult flea beetles — including many about to deposit eggs — were placed in each of four field cages. The weed density averaged 49.3 pigweeds per 2,500 cm² and the weeds were 12 cm tall at release time.

Hemenway and Whitcomb (1968) reported that in the laboratory, eggs of *D. glabrata* reared continuously at 26.7°C required 5.9 (range 4-8) days to hatch. In the field, the first larvae were seen 21 days after release of adult beetles. Average weekly temperatures for the three weeks of June 26 - July 10 were 16.7°C, 21.7°C, and 21.1°C.

In 1980, nearly 200 adult flea beetles were again released. Approximately 40 were placed in each of five cages.

Both larvae and adult beetles feed heavily on pigweed. However, beetle populations developed slowly early in the season and the damage they caused occurred too late in the season to be of much help in reducing pigweed to non-competitive status or in preventing the plants from setting seeds. Density in number of weeds per cage was not reduced. In some cages, 100% of the foliage was consumed: only the stems and leaf veins remained. In cages completely devoid of green pigweed foliage, slight feeding damage by adults on the sugarbeets was observed. We also suspect that the larvae of the flea beetles were subject to predation by numerous native predaceous carabid beetles. We observed that these flea beetles failed to overwinter in 1980-81, a rather mild winter by North Dakota standards.

Bindweed and Leafy Spurge. An initial survey for native insects associated with bindweed, *Convolvulus* sp., was conducted during the summers of 1977 and 1978 in North Dakota. Several species of native beetles are frequent defoliators in bindweed and include the tortoise beetles *Agroiconota bivittata* Say, *Deloyala guttata* Oliver, *Chelymorpha cassidea* Fab. (Fig 4) and *Metriona bicolor* Fab. *Megacerus discoideus* Say, a seed feeding bruchid beetle, was also quite common. Thusfar no tests have been made to evaluate the effectiveness of these beetles.

Leafy spurge is an extremely important economic pest in North Dakota, but so far no foreign insects have been available for biological control of it in North Dakota.

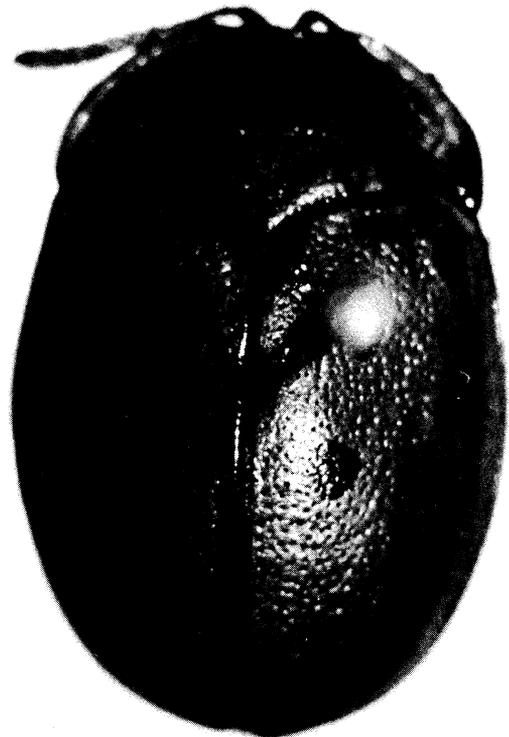


Figure 4

NDSU entomologists hope to receive some within the next few years. The leafy spurge hawk moth was tested in Nebraska (Forwood and McCarty, 1980) and South Dakota where it fared poorly. The USDA, as well as Canadian researchers, are currently testing the spurge borer, *Oberea erythrocephala* (Schrank), a long-horned beetle. In addition, the Canadians are testing several European species of flea beetles the larvae of which feed in the roots of leafy spurge: viz. *Aphthona cyarissiae* Koch, *A. czwalinai* Weise, and *A. flava* Guillebeau. In addition, they hope to collect and screen two species of caterpillars, *Lobesia* sp. and *Clepsis* sp., and two gall producers, *Dasyneura* sp., a gall midge, and *Eriophyes* sp., a gall mite.

Although the initial investment for biological control of weeds is costly, successful introductions have proved economically worthwhile.

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Figures

Figs. 1-4. Adults of beetles that feed on weeds in North Dakota. 1. Seed feeding weevil, *Rhinocyllus conicus* (Froelich) and 2. Root and lower stem thistle weevil, *Ceutorrhynchidius horridus* (Panzer), both in-

roduced against musk or nodding thistle. 3. Pigweed flea beetle, *Disonycha glabrata* (Fab.) introduced against rough or redroot pigweed. 4. *Chelymorpha cassidea* (Fab.), the argus tortoise beetle, a native species that feeds on bindweed.

continued from Guest Column

mittee members realized that an interdisciplinary approach was required — an approach involving more than animal scientists alone. A steering committee was formed to design a national conference on "Animal Agriculture: Research to Meet Human Needs in the 21st Century." During May, 1980, 210 producer and industry representatives, nutritionists and political scientists convened at Boyne Mountain, Michigan. Following are the research priorities presented by the American Society of Animal Science for discussion at this meeting.

1. Improving reproductive capacity.
2. Identification of cellular mechanisms controlling the synthesis of animal proteins and lipids.
3. Beneficial manipulation of microflora in the intestinal tract.
4. Genetic engineering for production traits in disease resistance.
5. Increased utilization of cellulose.

These five research areas are similar to research priorities identified by livestock producers in North Dakota. Some of you will be quick to point out that one major area of concern is missing and that is the concern of animal health and animal behavior. Needs in this research area have been prioritized by others and were not included in the American Society of Animal Science thrust area. The same is true of the food processing and acceptability. There is much need to develop technology for conserving animal products for human consumption and minimizing energy, water, product distribution and marketing costs. We must also develop rapid methods for assessing product quality and safety and expand basic research to resolve problems associated with flavor characteristics, microbiological spoilage, safety, appearance and meat tenderness.

Research presently underway at North Dakota State University relates to the priority items which have been indicated. We are presently evaluating our research pro-

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